524

TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

Ser. II, Vol. 3 JUNE, 1941 No. 8

SECTION OF GEOLOGY AND MINERALOGY

MAY 5, 1941

DOCTOR JOHN B. LUCKE, University of Connecticut, Storrs, Connecticut; Gravel Indications of New Jersey Drainage. (This lecture was illustrated by lantern slides.)

The Fall Zone area of New Jersey in the Raritan Valley near New Brunswick has acquired increasing geomorphic importance as a result of recent efforts to decipher river history on the eastern Appalachian slope.

In his *Stream Sculpture on the Atlantic Slope*, Douglas Johnson proposed that the Hudson River once crossed the Palisades at Sparkill, cut paired gaps across the Watchung Mountains at Paterson and Summit, and after joining the Raritan near Bound Brook, flowed directly to the sea as a master "Hudson-Raritan" in the approximate present position of the lower Raritan River. More recently, in a study of the *Origin and Structure of Pensauken Gravel*, Campbell and Bascom proposed that both the Hudson and Delaware Rivers once crossed what are now the high ridges of New Jersey at the same time, to join in a broad belt of aggradation near Bound Brook, and thence to flow southwestward to Trenton, crossing the Fall Zone approximately at Rocky Hill.

TRANSACTIONS of The New York Academy of Sciences, Series II, Volume 3, No. 8, June, 1941.

This publication is distributed to Members and is published monthly from November to June, inclusive, at 8–10 W. King Street, Lancaster, Pa., by The New York Academy of Sciences, Seventy-ninth Street and Central Park West, New York City.

Associate Editor: Eunice Thomas Miner, Executive Secretary.

Entered as second-class matter December 2, 1938, at the post office at Lancaster, Pa., under the act of August 24, 1912.

The present study is based upon a careful search for distinctively fluvial gravels in the Raritan valley. It was found that at least six exposures revealed beds of very coarse, well-rounded stream gravel, differing markedly from the typical Pensauken formation with which they have hitherto been mapped. All the observed outcrops occur upon or immediately east of the Fall Zone. The gravels are regarded as definitely fluvial and essentially *in situ*. They contain boulders of maximum diameters as large as twenty inches, all of which are extremely well-rounded, and in such concentration that pebble counts, comprising a minimum of 100 pieces, were readily made.

The pebble counts indicate complete disparity between the lithology of the observed gravels and the composition of gravels assumed to have been deposited by the present Raritan River. In order of abundance, the types of rock comprising the described gravels are quartzite, vein quartz, vitreous red sandstone, and vitreous conglomerate. These four rock types found in the typically fluvial deposits are present in average percentages of 72, 15, 7, and 3, respectively. All other possible rock types comprise less than 3 percent of any of the distinctively fluvial gravels.

The dissimilarity between the observed deposits and the rocks found in the Raritan watershed indicates deposition by a larger stream draining a region outside New Jersey. The described boulders occur in two local areas in such topographic position that they appear to represent old, high, 110-foot and 70-foot floodplain remnants. In other exposures, boulders of the same character appear to be incorporated as a basal conglomerate in the Pensauken formation. The writer believes, therefore, that they are distinctly older than the Pensauken, perhaps even of Tertiary origin, and that where they are found associated with the Pensauken they have been inherited from the high, floodplain remnants described.

Neither the "Hudson-Raritan" hypothesis of Johnson, nor the "Hudson-Delaware" hypothesis of Campbell and Bascom seem entirely adequate to account for the observed gravels. The

field data offer some serious objections to the latter hypothesis and can be regarded as in accord with Johnson's "Hudson-Raritan" hypothesis only by redefining "Raritan." The writer proposes that an ancient Delaware (or any stream regardless of name which drained the quartzite-rich regions of northeastern and eastern Pennsylvania) once crossed the present highland ridges of New Jersey, proceeding directly to the sea in a normal superposed-consequent manner via the present lower course of the Raritan River. The new hypothesis specifically accounts for the high-level gravels described near New Brunswick. It presents, however, no objections to the possibility that both the Hudson and the "Delaware," after merging somewhere near Bound Brook, flowed as one stream to the sea, after Johnson. But since the postulated master stream is enormously longer than any suggested by the name "Raritan," the writer proposes that the tentative conclusions here offered be designated the "Delaware-Raritan" hypothesis, unmistakably drawing attention to the necessity of headwater erosion in Pennsylvania.

The hypothesis postulated as in closest accord with the facts, is that a large, superposed-consequent river, draining an area northwest or west of the New Jersey highlands and here called the "Delaware-Raritan," flowed southeast across northern New Jersey in pre-Pensauken time, possibly being swelled by a junction with an early Hudson River near Bound Brook, and finally crossed the Fall Zone in the approximate position of the present Raritan River.

SECTION OF BIOLOGY

MAY 12, 1941

DOCTOR L. S. STONE, Bronson Professor of Comparative Anatomy, Yale University School of Medicine, New Haven, Connecticut: *Transplantation of the Vertebrate Eye and Return of Vision.* (This lecture was illustrated by colored motion pictures and lantern slides.)

During the past fifteen years, I have been interested in experimental studies involving development and regeneration of the vertebrate eye in all ages from the embryo to the adult. In these investigations, most of the studies have centered about the amphibia, although fishes and mammals have also been included. These researches involve many hundreds of experiments concerned chiefly with transplantations of the entire eye or parts of the eye. For the present discussion we shall confine our attention to the results obtained when the entire functional eye is grafted, i. e., when the eye is excised and either reimplanted or transplanted to another animal. In any case, the eye is normally oriented in the orbit.

When the entire eye is transplanted in fishes, for example, the common *Fundulus*, the graft heals readily and circulation is returned in a few days. For a few weeks the living eye appears normal, then pigment invades the graft. The eye gradually becomes opaque and is slowly resorbed, for it has no power of regeneration.

In various species of frog tadpoles, the transplanted eyes heal rapidly and grow with all the appearance of a normal eye even long after the host has changed into an adult frog. With the exception of a permanent loss of a few ganglion cells in the retina, all the tissues survive. The eyes, however, do not possess the power to regenerate a new optic nerve and, therefore, vision is never recovered in the graft.

In various types of salamanders, the eyes can be successfully transplanted with complete regeneration of the optic nerve and return of visual function. In young larval stages of *Amblystoma*, for example, the eyes usually show little change following operation. There is often a slight temporary decrease in size due to a loss of varying amounts of fluid and blood cells at the time of operation. Circulation returns within a few days and the graft soon reaches the size and appearance of the normal control. This is maintained as long as a year after metamorphosis. Occasionally after operation there is a temporary opacity of the cornea but, if it occurs, it disappears within a few days. The only permanent effect of the operation is registered in the ganglion cell-layer of the retina. This usually involves the loss of only a few cells which takes place during the first few days after operation. The new optic nerve is fully regenerated and connects with the brain as early as 3 weeks after operation. We have shown, furthermore, that the larval eyes between two entirely different species (*Amblystoma punctatum* and *A. tigrinum*) can be successfully transplanted with return of function.

In adult forms of different species of salamanders, the functional eye can also be successfully transplanted with return of all the functions in the graft. This can be accomplished repeatedly in the same eye transplanted several times in succession to different hosts. The common vermilion spotted newt (*Triturus viridescens*) will be taken as an example. The demonstration given in the colored motion pictures shows the technique of operation used on all of the aquatic forms which we have investigated. The animals are anaesthetized in a dilute solution of chloretone. Two animals, in which the right eyes are to be exchanged, are laid side by side on moist cotton. The operation is done under a compound dissecting microscope with needle-pointed iridectomy scissors and forceps. In each eye, the conjunctival sac is first excised, then all the deeper structures including the optic nerve are severed. The eyes are then carefully removed and exchanged between the two hosts. In all cases, the eyes are carefully placed in the new orbits and normally orientated. The

adhesive quality of the tissues in the eye socket are sufficient to hold the graft in place so that no sutures are required. The eyes heal in place in a few days and circulation is soon reestablished.

In the living *Triturus* eye, for example, one can see temporary changes in the pigment pattern of the iris. The normal appearance, however, returns in two or three months. Histological sections show that the retina degenerates during the first three weeks, except at the periphery or ciliary margin. From the latter, a new retina regenerates and is fully differentiated by the end of two months. During this time, a new optic nerve is formed connecting the eye with the brain. From two and one half to three months after operation, return of vision can be demonstrated. This is shown in the motion pictures where the animal is prepared for visual tests by first excising the left normal eye. The host then possesses only one eye, the transplanted one. The animal is placed in a small glass aquarium, and when a dark colored lure, such as a piece of wood or rubber, impaled on the end of a wire, is moved about two inches from the outside of the aquarium, the animal swims vigorously about following and snapping at the moving object. The experiment is carefully controlled to eliminate extraneous disturbances such as gustatory, olfactory, and mechanical stimuli. The reactions are the same as in the case of visual responses in a normal control animal.

Regarding experiments on mammals, it may be said, at this point that the eyes of rats at different ages after birth have also been grafted. In no case did the eye persist longer than four months. There was final resorption as in the case of fish eyes. However, at the present time, the opossum is being studied as the most promising type of mammal for eye transplantations. At birth, the young are quite embryonic. The eye, at this time, is in the same stage of development as a five week old human embryo. This condition lends itself to an experimental analysis in a way that is not possible in any other mammal.

In connection with studies of the transplanted eye in different amphibians, interesting observations were made on the ability of the lens to resist degeneration. An exception to the rule is found

in the common newt (*Triturus viridescens*), where the lens degenerates completely during the first month after operation. Replacement of the lens, however, took place by a growth of cells from the pupillary margin of the dorsal rim of the iris, as has been shown in cases following lensectomy. From our experimental studies and from the results of a critical analysis of the literature, we have concluded that, with the exception of the small group of salamanders known as the *Triturus*, there is no proof at present that any other vertebrate eye can restore the lens after it is once lost.

We have investigated this problem extensively in an attempt to discover the factors which release this phenomenal growth of the new lens. Various combinations of experimental conditions have been examined in which the dorsal rim of the iris has been transplanted into the eye and the body cavity. The results so far have shown that the release of lens regeneration from the transplanted iris takes place in any of the environmental conditions, but that the presence of a normal fully developed lens inhibits its growth, perhaps through some biochemical medium.

This remarkable method of lens replacement is also unique when one considers the origin and normal course of lens development. In our own studies on lens induction and in experimentally produced cyclopean monsters, we have shown, as well as other investigators, that, through the prechordal mesoderm, influences are released to localize the eye-forming centers in the primitive nervous system. In some way, the eye-forming centers, in turn, bestow upon the adjacent surface ectodermal cells the capacity to form a lens. This means that the original lens does not arise from cells of the eye-forming center which later form the iris. However, it might be possible that the presumptive iris-forming region of the early eye center is the part that is playing the most important role in transferring to the surface ectoderm the capacity for lens formation. In any case, by some unusual event in *Triturus*, this region, now localized in epithelial cells of the dorsal rim of the iris, strongly retains lens-forming capacity. From our own experiments, we know there is no evidence that the iris can release this

influence for lens formation to other cells in the way the embryonic eye center does to the surface ectoderm. Therefore, it appears that the epithelial cells of the iris concerned with lens formation can only respond under the proper conditions (loss of original lens) by proliferation. Herein may lie a clue to a better understanding of the fundamental factors which control the general process that we call regeneration.

SECTION OF PSYCHOLOGY

MAY 19, 1941

DOCTOR JOHN VOLKMANN, Columbia University: *Quantum Theory in Psychology.*

Dr. S. S. Stevens and Dr. C. T. Morgan of Harvard University, together with the author, have been interested in verifying and developing a quantum theory of discrimination, proposed in its essentials by G. von Békésy.

Like any other science, psychology should provide fundamental data which can then be used in the solution of specific problems. Measures of discrimination constitute fundamental data. The only difficulty is that the classical methods of measuring discrimination contain certain arbitrary features that prevent the results from being interpreted in a straightforward way. Classically, the difference-limen is defined as the stimulus-increment that is noticed 50 per cent of the time. This definition is arbitrary. Its criterion might just as well be set at 75 per cent, —a figure that some have preferred.

The quantal theory may make it possible to secure fundamental data and to avoid any arbitrary features of method. It assumes, in the first place, that a given stimulus-magnitude produces an all-or-none excitation of a certain number of "neural units" (quanta), and that there is left a small *surplus of stimulation*, less than the amount needed to excite one additional unit. The theory assumes, in the second place, that both the number of units excited and the amount of surplus stimulation fluctuate during the presentation of a non-varying stimulus. The fluctuation may proceed from any source. It may be random or rhythmic. The essential point is that it produces varying amounts of surplus stimulation, each of these amounts being as likely to occur as any other amount.

On the basis of these assumptions, the quantal theory is able to explain in a general way the results usually obtained in dis-

crimination experiments—the sigmoid form, for example, of the psychometric function, which relates the frequency with which a stimulus-increment is noticed to the size of that increment. What is more striking, the theory predicts an entirely different psychometric function in a special case, namely, when the stimulus-increment is inserted very rapidly. There is then not enough time between the standard stimulus and the inserted increment for fluctuation in sensitivity to occur. There can be found a stimulus-increment that will *just* suffice *always* to excite an additional neural unit. It supplements the surplus of stimulation, no matter how small this surplus may be. In the simplest case, in which the excitation of one additional neural unit gives rise to a perception of difference, the size of this increment is the measure of the size of the quantum. This measure is derived from the assumptions listed above. There is nothing arbitrary about it.

Under this special condition of rapid change, then, a certain increment (the quantal increment) will give rise to a judgment of "different," 100 per cent of the time. Correspondingly, a zero increment *never* excites an additional neural unit, and it yields a judgment of "different," 0 per cent of the time. In this way, the theory predicts two points on the psychometric function—at 0 and 100 per cent. Between successive insertions of the stimulus-increment, there is ample time for the sensitivity of the system to change, so that, as previously assumed, an unvarying stimulus will excite varying numbers of neural units with varying amounts of surplus stimulation. The surplus will vary between the limits, zero and one quantum, and its various values will occur with approximately equal frequency. Now a small stimulus-increment will supplement an existing surplus, and excite an additional unit, only if this surplus is a relatively large one. This will happen a small proportion of the time. A large stimulus-increment will supplement either a small or a large surplus of stimulation. Hence it will excite an additional neural unit a large proportion of the time. The more rigid mathematical argument shows that, between the limits 0 and 100 per cent, the frequency with which an additional unit is excited is directly proportional to the size of

the stimulus-increment. Instead of being sigmoid, the psychometric function is an oblique straight line.

Von Békésy supported his theory with data upon the discrimination of auditory loudness. He presented tones lasting 0.3 seconds, and, in the middle of this brief time, changed the intensity of the tones rapidly. A few highly practised observers were able to perceive regularly increments which excited a single additional neural unit (first-quantum discrimination). The psychometric functions were acceptably rectilinear. With less practice, the observers required increments which excited *two* additional neural units (second-quantum discrimination). As predicted from the theory and actually obtained, the function was still rectilinear between 0 and 100 per cent, but it was displaced the width of one quantum and had the expected slope. For the theory allows us to predict the slope of this second-quantum function—the slope is such that the increment perceived 100 per cent of the time is twice the largest increment which is never perceived.

Our own experiment upon loudness-discrimination employed a continuous 1000-cycle tone, which, once every 3.0 seconds, was augmented in intensity for 0.15 seconds. A system of electrical filters prevented the transition from one level of intensity to another from being too abrupt. The size of the increment was varied in accordance with a modified form of the constant method. The observer pressed a key, whenever he heard a pulse in loudness, and refrained from pressing, when he did not hear one. Proceeding in this way, he produced a number of psychometric functions, which showed plainly the characteristics of second-quantum discrimination. The slope of the straight lines followed the rule mentioned above, and this fact alone constitutes strong support for a quantal theory.

Although it was proposed by von Békésy specifically for the discrimination of auditory intensity, the quantal theory contains no assumption which limits its scope in any obvious way. It may conceivably apply to the discrimination of many aspects, or all aspects. Realizing this, we examined another case—the

discrimination of tonal pitch. Increments of frequency were added, briefly and periodically, to a steady tone, and the observer pressed a key each time he heard one of these increments. The same system of filters prevented the changes in frequency from being too abrupt. Six observers gave results typical of second-quantum discrimination, including the crucial relations of slope. By statistical test, the rectilinear quantal functions fit the data considerably better than the sigmoid functions of the classical theory. There are quanta of pitch-discrimination, then, as well as quanta of loudness-discrimination.

Are the pitch-quanta peripheral or central in origin? To shed light on this question, data from binaural stimulation were compared with data from monaural stimulation. All four observers showed quantal discrimination of binaural stimulation. Three of the four had binaural quanta that were about two-thirds as large as their monaural quanta. The two ears worked together to produce a finer quantal discrimination. Hence, the quantum appears to be central rather than peripheral. However, since we do not know of a correlation with any identifiable structure, the quantum is best regarded as a functional unit.

The size of the quantum varies considerably between observers. Occasionally and for no known reason, it also varies in the results of single observers from one experimental session to another. There is a regular variation of quantum-size with sensation-level, similar in form to the relation obtained earlier by Shower and Biddulph. In absolute value, the quantal measures of differential sensitivity are smaller than the measures yielded by the usual methods.

Following the idea that the quantal theory holds generally, the author has been trying to find a quantum of visual spatial discrimination. The observer looks with one eye directly at a very small, brightly illuminated point. Periodically and rapidly, this point is moved through a small known distance and moved back again. By pressing a key, the observer reports the instances in which he sees the point move. Apparently, the conditions for quantal discrimination are very critical, but as these conditions

are more and more closely approximated, the data fall more and more plainly in the curve that is characteristic of first-quantum discrimination. It is a fair conjecture that, in this case, the quanta are peripheral rather than central in origin, and that the variation in sensitivity proceeds from small changes in the locus of stimulation on the retina.

The quantal theory presents a new list of problems for experimental psychology to solve. For example, neither the necessary conditions nor the optimal conditions for obtaining quantal discrimination are completely known. The physiological correlates of quantal discrimination are also not known. If the quantal theory holds generally and if its conditions can be met, it should be possible to find many other specific instances of quantal discrimination. Perhaps there are quanta of psychological magnitude as well as quanta of differential sensitivity. But the most important task of the quantum research is to provide a set of fundamental data in the field of discrimination.

ANALYSIS OF SEA WATER IN A CLOSED AQUARIUM[1]

By

Louise P. Wilson and Mary A. Griggs

Wellesley College

Wellesley College has maintained in its aquarium room, a closed system of circulating sea water which involves the typical features of such systems, that is, a series of aquaria which drain through a large gravel-filled filter into an open storage reservoir from which water is pumped again into the aquaria. The present aquarium water was transported in water trucks from South Boston Harbor in December 1933. The system holds 14,000 gallons to which approximately 100 gallons of lake water are added weekly to correct for evaporation. Sodium bicarbonate is added periodically in order to maintain a constant hydrogen ion concentration. An average of 12 pounds a year has been used since 1934. Less is required immediately after cleaning the filter and progressively more as the filter becomes clogged with organic wastes. Each of the three large display aquaria are constantly aerated with compressed air. No temperature control is attempted.

To maintain animals in a healthy condition for exhibition and experimental or life history studies, it is essential that the chemical and physical properties be kept as nearly like those of normal sea water as possible. In order to test the success of this laboratory in maintaining such a suitable salt water environment, examination of physical properties and spectrographic analyses of certain mineral constituents of the aquarium water were made and compared with like analyses of water from Boston Harbor.

Analyses were made on four samples of sea water collected under the following conditions:

[1] Special Contribution to the Transactions. This paper was not presented at an Academy meeting.

I. Boston City Aquarium. Collected November 1939. An unknown volume of fresh sea water had recently been added to the water which had been in the aquarium for a year.

II. South Boston Harbor. Collected November 1939, high tide.

III. Wellesley College Zoology Aquarium. Collected November 18, 1939—twenty four hours after the supply tank had been filled with fresh lake water.

IV. Wellesley College Zoology Aquarium. Collected November 9, 1939—six days after the supply tank had been filled with fresh lake water.

For comparison, the following table also contains results obtained by using analytical chemical methods:

V. Composition of Woods Hole sea water (1).

VI. Probable composition of sea water as computed from various sources by Robertson and Webb (2).

The only preparation required for the analysis was quantitative dilution for some of the determinations. Calcium, magnesium, potassium and sodium were determined by the Lundegardh spectrographic method, the intensity of the lines being read by means of a Zeiss Spectrum Line Photometer. The chloride was determined by titration with silver nitrate. The results are as follows all expressed in grams of the metal per liter of sea water:

Sample	Calcium	Magnesium	Potassium	Sodium	Chlorine	pH (3)
I	0.39	1.2	0.49	9.0	18.2	7.67
II	0.39	1.2	0.47	9.4	17.8	7.65
III	0.40	1.2	0.57	10.8	18.4	8.22
IV	0.42	1.3	0.60	11.0	18.9	8.10
V	0.428	1.300	0.412	8.8	18.35	8.3
VI	0.42	1.31	0.39	10.7	19.3	

The aquarium waters differed appreciably from the sea waters only in the potassium content. In order to check these potassium

results, since there were no records of potassium analyses on the water from South Boston Harbor, water from Woods Hole, Nobska Beach was analyzed. The results in grams of potassium per liter are as follows:

1st portion 0.45
2nd portion 0.44
3rd portion 0.43
4th portion 0.43

Two further tests in which known weights of potassium chloride were used showed an error of only 1% in analyses made by the same method. The result for potassium in Woods Hole water is close to that obtained by Page (1) and agrees with results obtained by Wheeler (4) for Beaufort Harbor water. It therefore seems reasonable to suppose that potassium accumulates in the aquarium from the decomposition of food and waste products. Practically all added food is fish muscle. The same factor probably accounts for the high potassium content of Boston Harbor. Contrary to our results, Breder and Howley (5) show a slight decrease of potassium in the circulating system of the New York Aquarium.

All results for the water from the Wellesley aquarium are slightly higher for the sample collected six days after filling, than for the sample collected only one day after filling. This, of course, is reasonable, since there is constant evaporation which would leave the minerals more concentrated. It is noteworthy that the principal ions of sea water may be kept so nearly constant without elaborate methods of chemical control.

In 1936 and 1937, daily records of specific gravity and temperature were made. The specific gravity, measured with a hydrometer and corrected to 15° C., varied between 1.020 and 1.026 throughout the year. Temperature in the storage tank varied from an average of 20.8° C. in February to an average of 22.5° C. in August. The lake water used for dilution varied from as low as 4° C., in winter, to 19° C. in summer. The cool basement storage tank in summer and the heating plant in winter tend to equalize the temperature.

A brief study of the pH of the water from the aquarium was made in January, 1940, by the use of the Beckman pH meter. Samples were collected on seven consecutive days and the pH was always within one hundredth of a pH from 8.29, even though the fresh water was added after the sample for the second day had been obtained. This indicates the complete buffering of the sea water probably aided by the sodium bicarbonate which may also account for the high alkalinity.

Among the animals kept constantly in the aquaria, are species of bony fishes, Arthropoda, Mollusca, Coelenterata, Echinodermata, and a few Annelida. *Limulus* has moulted normally in the aquarium for four years and *Busycon* has been kept for six years. Tautog and sea bass, among the vertebrates, have been kept five years. An encrusting coelenterate has maintained itself for several years and has spread over the entire aquarium.

BIBLIOGRAPHY

1. Page, I. R., The composition of Woods Hole sea water. Biol. Bull., *52*, 161, 1937.
2. Robertson, J. D. and Webb, D. A., The micro-estimation of Na, K, Ca, Mg, Cl, and SO_4 in sea water and the body fluids of marine animals. Journ. of Exper. Biol., *16*, 155, 1939.
3. The pH values of the four samples were taken in January after they had been stored in glass bottles for about three months.
4. Wheeler, A. S., Composition of sea waters. Jour. Am. Chem. Soc., *32*, 646, 1910.
5. Breder, C. M., Jr., and Howley, T. H., The chemical control of closed circulating systems of sea water in aquaria for tropical marine fishes. Zoologica, *9*, 403, 1931.

NEW MEMBERS

Elected May 5, 1941

LIFE MEMBERS

Iddings, Carl, Ph.D., Chemistry, Chemical Engineering, Vice President, General Manager, The Muralo Company, Staten Island, N. Y.

Kovarik, Alois F., Ph.D., Sc.D., Professor, Chemistry, Sloane Physics Laboratory, Yale University, New Haven, Conn.

ACTIVE MEMBERS

Beard, Stanley D., Ph.B., Medical Biology, Immunology, Vice President, Lederle Laboratories, Inc., New York, N. Y.

Besancon, Robert M., M.A., Associate, Physics, University of Illinois, Chicago, Ill.

Bosee, Roland A., Ch.D., Biochemistry, Vice President, Laboratory Director, Endoproducts, Inc., New York, N. Y.

Isenburger, Herbert R., Physics, Chemistry, President, St. John X-Ray Service, Inc., Long Island City, N. Y.

Jacobs, Morris B., Ph.D., Chemist, Department of Health, City of New York, New York, N. Y.

James, T. H., Ph.D., Research Chemist, Eastman Kodak Company, Rochester, N. Y.

Jameson, Eloise, Ph.D., Research Associate, Medicine, Stanford University, School of Medicine, San Francisco, Calif.

Johnson, Harry I., Ph.D., Professor, Director, Science, Roanoke College, Salem, Va.

Jordan, Hovey, M.S., M.A., Professor, Histology, Embryology, College of Medicine, University of Vermont, Burlington, Vt.

Jungherr, Erwin L., M.D., Professor, Animal Diseases, University of Connecticut, Storrs, Conn.

Just, Ernest Everett, Ph.D., Professor, Zoology, Howard University, Washington, D. C.

Juterbock, Edwin E., Ph.D., Chemical Engineer, Standard Oil Company of New Jersey, New York, N. Y.

Kato, Katsuji, Ph.D., M.D., Sc.D., Assistant Professor, Pediatrics, University of Chicago, Chicago, Ill.

Kearns, Walter M., M.D., M.Sc., Urology, President, Johnston Emergency Hospital, Milwaukee, Wis.

Kemp, Archie R., M.S., In charge of Organic Chemical Research, Bell Telephone Laboratories, New York, N. Y.

Kemp, Jarold Elting, M.D., Associate, Venereal Diseases, Lecturer, Medicine, Johns Hopkins University, Baltimore, Md.

Kinney, Gilbert Ford, Ph.D., Head Instructor, Chemistry, Pratt Institute, Brooklyn, N. Y.

Koehring, Vera, Ph.D., Instructor, Biological Sciences, Hunter College, New York, N. Y.

Kollmorgen, Frederick Ludwig, Optics, President, Kollmorgen Optical Corp., Brooklyn, N. Y.

Kranz, Fred W., Ph.D., Physics, Vice-President, Works Manager, Sonotone Corp., Elmsford, N. Y.

Kurzrok, Raphael, Ph.D., M.D., Obstetrics, Gynecology, Physician, New York, N. Y.

Landis, Quick, Ph.D., Research Chemist, The Fleischmann Laboratories, New York, N. Y.

Langfeld, Herbert Sidney, Ph.D., Professor, Chairman, Psychology, Princeton University, Princeton, N. J.

Leland, Jessica Pendleton, Ph.D., Research Assistant, Medicine, College of Physicians & Surgeons, Columbia University, New York, N. Y.

Lowenheim, Frederick A., Ph.D., Research Chemist, Metal & Thermit Corp., Carteret, N. J.

Luhde, Ernest T., Biology, Curator, Stamford Museum of Natural History, Stamford, Conn.

McClung, Leland S., Ph.D., Assistant Professor, Bacteriology, Indiana University, Bloomington, Ind.

McCoy, Elizabeth, Ph.D., Associate Professor, Bacteriology, Immunology, University of Wisconsin, Madison, Wis.

McDowell, Elizabeth Dickinson, Ph.D., Lecturer, Psychology, Speech Science, Hunter College, New York, N. Y.

Stanley, Wendell Meredith, Ph.D., D.Sc., Medical Research, Member, The Rockefeller Institute for Medical Research, New York, N. Y.

Weissberger, Arnold, Ph.D., Research Chemist, Eastman Kodak Company, Rochester, N. Y.

ASSOCIATE MEMBERS

Ballard, Stanley S., Ph.D., Assistant Professor, Physics, University of Hawaii, Honolulu, Hawaii.

Beers, Roland F., E.E., M.S., Geology, Geophysics, President, The Geotechnical Corp., Cambridge, Mass.

Belda, Walter H., Ph.D., Professor, Biology, St. Francis Seminary, St. Francis, Wis.

Bergman, Herbert F., Ph.D., Senior Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Amherst, Mass.

Berkman, Anton H., Ph.D., Professor, Chairman, Biological Sciences, Texas College of Mines & Metallurgy, El Paso, Texas.

Bond, Eva, Ph.D., Professor, Psychology, College of William & Mary, Williamsburg, Va.

Boyd, T. A., Ch.E., Chemistry, Department Head, Research Laboratories Division, General Motors Corp., Detroit, Mich.

Brady, Ewing P., D.D.S., Chemical, Medical and Public Health, Supervisor, Health Education, St. Louis Public School, St. Louis, Mo.

Brooks, Charles Franklin, Ph.D., Professor, Meteorology, Director, Blue Hills Meteorological Observatory, Harvard University, Cambridge, Mass.

Burack, Benjamin, Ph.D., Instructor, Psychology, Schurz Evening Junior College, Chicago, Ill.

Hansbrough, John Raymond, Ph.D., Forest Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, New Haven, Conn.

Kamerling, Samuel E., Ph.D., Associate Professor, Chemistry, Bowdoin College, Brunswick, Maine.

Kountz, William B., M.D., Assistant Professor, Clinical Medicine, Washington University, School of Medicine, St. Louis, Mo.

Kuster, Kimber Cleaver, Ph.D., Professor, Biology, State Teachers College, Bloomsburg, Pa.

Ladenburg, Rudolf, Ph.D. (Munich), Physics, Brackett Research Professor, Princeton University, Princeton, N. J.

Langner, Helen P., M.D., Associate Physician, Assistant Professor, Hygiene, Vassar College, Poughkeepsie, N. Y.

Larrabee, Austin Park, Ph.D., Professor, Biology, Yankton College, Yankton, S. Dak.

Larson, W. P., M.D., Professor, Bacteriology, Immunology, University of Minnesota, School of Medicine, Minneapolis, Minn.

Lebedeff, Gabriel A., Ph.D., Plant Breeder, Agricultural Experiment Station, Rio Piedras, P. R.

Lester, Oliver C., Ph.D., Professor, Physics, Dean, Graduate School, Vice-President, University of Colorado, Boulder, Colo.

LeVeque, Norma, Ph.D., Assistant Professor, Biology, University of Colorado, Boulder, Colo.

Lewis, Bernard, Ph.D., Physical Chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

Lively, Chauncy Clinton, Ph.D., Head, Psychology, Waynesburg College, Waynesburg, Pa.

Long, F. A., Ph.D., Assistant Professor, Chemistry, Cornell University, Ithaca, N. Y.

Lower, William E., M.D., Surgery, Director, Cleveland Clinic Foundation, Cleveland, Ohio.

Lucia, Eschscholtzia L., Ph.D., Associate Professor, Biometry, Chairman, Hygiene, University of California, Berkeley, Calif.

Lyons, William Reginald, Ph.D., Assistant Professor, Anatomy, University of California, Berkeley, Calif.

Mendiola, Nemesio Blanco, Ph.D., Professor, Agronomy, Director of Research, Agricultural College, Laguna, P. I.

Shakow, David, M.A., Chief Psychologist, Worcester State Hospital, Worcester, Mass.